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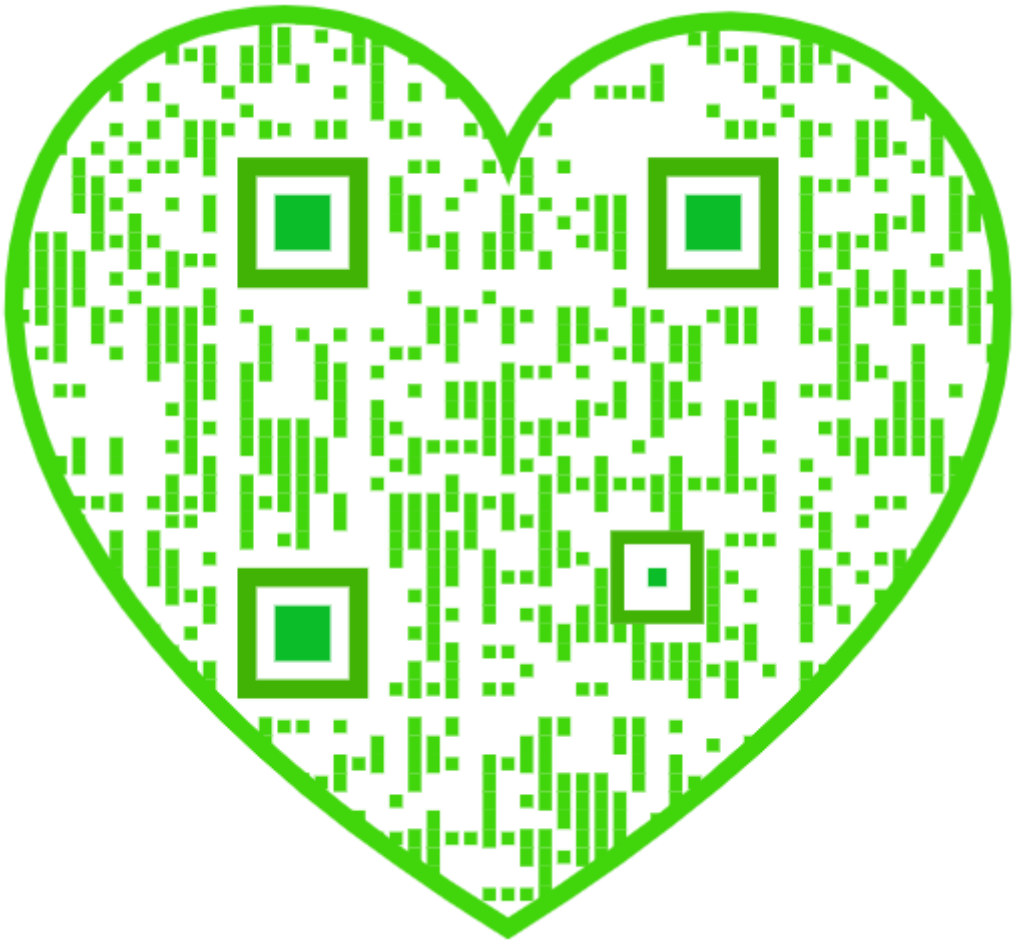

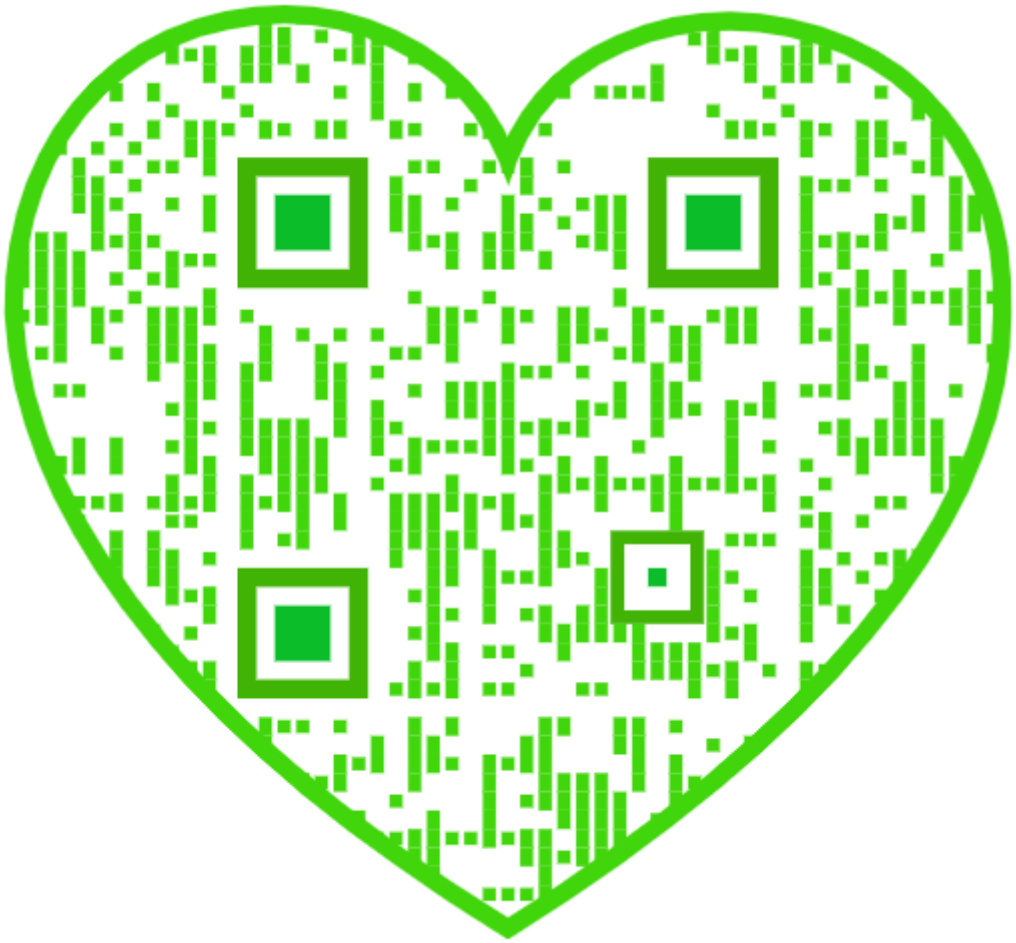

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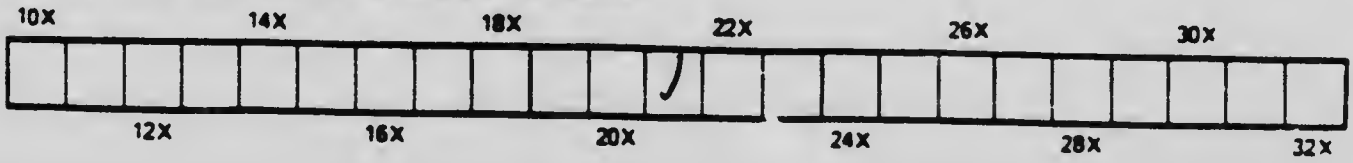

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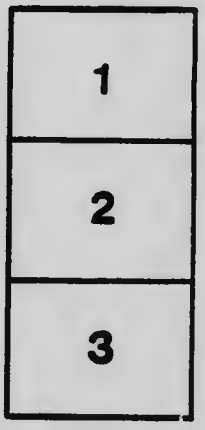

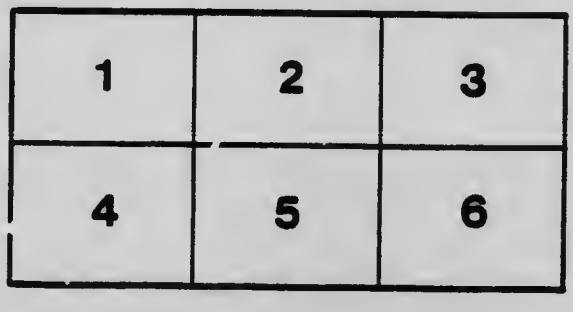

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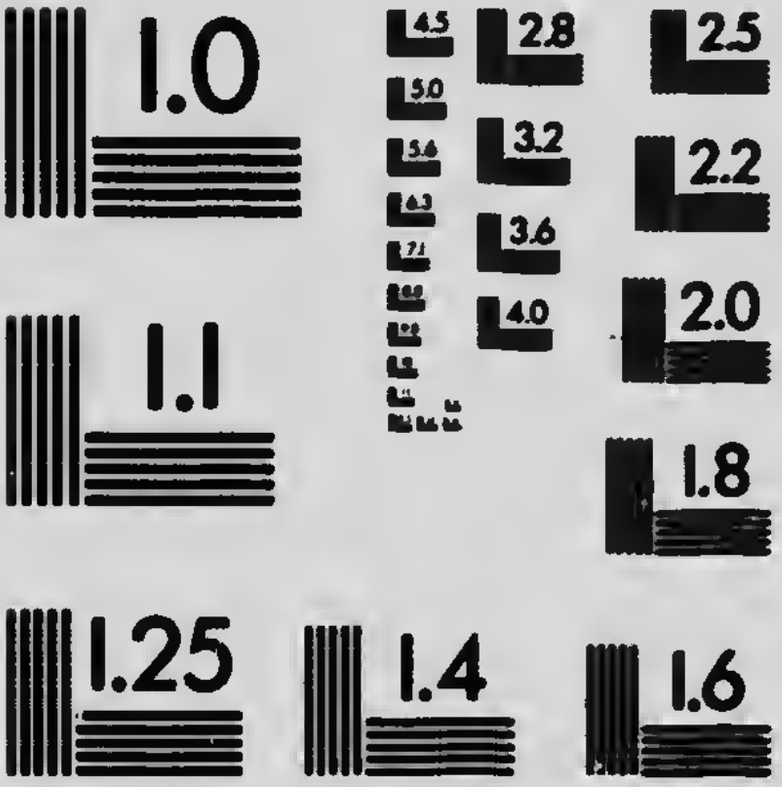

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Safety Lamps and Colliery Explosions

—BY—

JAMES ASHWORTH, M.E., Mount Chaddesden, England.

Acadia University Library
Wolfville, N. S. Canada

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Safety Lamps and Colliery Explosions.

By James Ashworth, M.E., Mount Chaddesden, England.

The fearful explosions which are continually occurring in various parts of the world, notably that of the Universal Colliery in South Wales, the Fraterville coal-mine in Tennessee on the 19th of last May, and lastly the one at the Fernie No. 2 tunnel workings of the Crow's Nest coal field, on the 22nd of May, about 7.30 p.m., are sufficient in themselves to cause those who have the charge of mines which give out firedamp, as well as those who have money invested in them, to seriously consider in what way this risk may be lessened, if not almost totally prevented.

It is suggested by the newspaper reports on the Fernie disaster, that the explosion originated from blasting in the coal. Similarly it was also suggested that the explosion at the Universal Colliery, Senghenydd, was caused in a similar way, but in the latter case only one witness could be found to suggest that an explosive had originated the disaster, though many witnesses proved that it could not have thus originated, and that it was in all probability caused by a totally different cause, and in a totally different part of the mine. The other cause and in all probability tbe true one, was the failure of a safety lamp to prevent the flame inside the lamp igniting the firedamp outside.

Under the Mines Regulation Acts of Parliament which regulate the management of coal-mines in Great Britain, all the lamps in use must be bonneted, that is to say, the gauze part of the lamp must be protected by a shield, so that an explosive air current cannot impinge directly on the naked gauze and cause it to become so quickly overheated as to destroy its protective value. Experiments have proved most conclusively that gauze lamps of the Davy type, such as the old Scotch gauze lamp, cannot withstand an explosive current of the lowest velocity on account of their large cubic contents, because the ignition of a large volume of firedamp exerts such a high velocity that the flame is forced through the mesh of the wire almost instantaneously, and without waiting to

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overheat the gauze. In like manner the naked Davy lamp which was in use by deputies, firemen, and shot firers for so many years throughout Great Britain, and was almost universally trusted by mine officials as the best lamp to use for the detection of firedamp, and also as the safest lamp for a workman or miner to use, was frequently condemned by experimentors until the Royal Commission on Accidents in Mines made experiments, and finally condemned the lamp as unsafe and reported that where used it must be protected by a shield covering the whole gauze. So great a favourite has the Davy lamp been in the hands of mine officials, that it is still in use in some mines in its original form (Fig. II), and in others when protected by a metal and glass shield, the glass being moveable as shown in the section Fig. III. Where the Davy lamp has not been in use for detecting firedamp the Stevenson (Fig. IIa) and the Clanny (Fig. IV) lamps have been used, but as these are as unsafe as the naked Davy, they also have been put to one side, excepting the latter when bonneted as shown in Fig. V.

The safety value of the Davy and Clanny lamps, both naked and bonneted, is well known so far as their exposure to explosive currents of air and firedamp are concerned, but when we expose them to mixtures of air, firedamp, and coal-dust, the latter factor completely upsets the confidence which the official tests of safety lamps in mixtures of firedamp and air have heretofore inspired. Thus, in the North of England Institute of Mining and Mechanical Engineers' Transactions, so long ago as 1880, a paper on Improved Safety Lamps of the Davy and Mueseler types will be found, in which it is shown by most careful experiments, which have been checked and verified, that if a mixture of air and firedamp contains only a normal per centage of coal dust, that is, just as much as the slow moving current of 370 feet per minute will lick up from the floor or carry along in suspension, 4½ per cent. of firedamp is sufficient to make the mixture so dangerous and highly explosive that a standard Davy lamp with a tin shield will pass the flame through the gauze in the short space of time of seven seconds. Without the presence of coal-dust such a lamp would safely withstand a similar current, containing only 4½ per cent. of firedamp, for many hours without failure. Nothing carries convincement to the miner's mind so forcibly as a practical experiment, and

although the evidence of disasters resulting from the failures of safety lamps are not very voluminous, yet they are so definite and accurate in their details that they cannot be pooh-poohed, and treated as *chateau d'Espagne*. Thus Mr. A. R. Sawyer, formerly an assistant inspector of mines in England, and now well known in the South African gold and coal fields, relates in one of his papers contributed to the North Staffordshire Institute of Mining and Mechanical Engineers, that on one occasion he took hold of a miner's Davy lamp, hanging at

FIG. I.—Scotch Gauze Lamp.

the face of a slightly dusty working, to examine it, and on giving it a slight tap with his hand, there was instantly a reddish flame of some magnitude outside the gauze, extending to a distance of about two inches. This fact makes it quite clear that if there had been any accumulation of firedamp in this dusty working, Mr. Sawyer would have lost his life, and we should not have had this valuable note out of

his book of experiences. Since then many other failures have occurred. For instance, at Bryncoch, South Wales, in 1896, a Davy lamp failed in a very low velocity of current which had become fouled by a heavy fall of roof in another part of the mine. Many other explosions resulting from the failure of Davy lamps to withstand conditions which are frequently to be found in most coal mines, might be added, but need

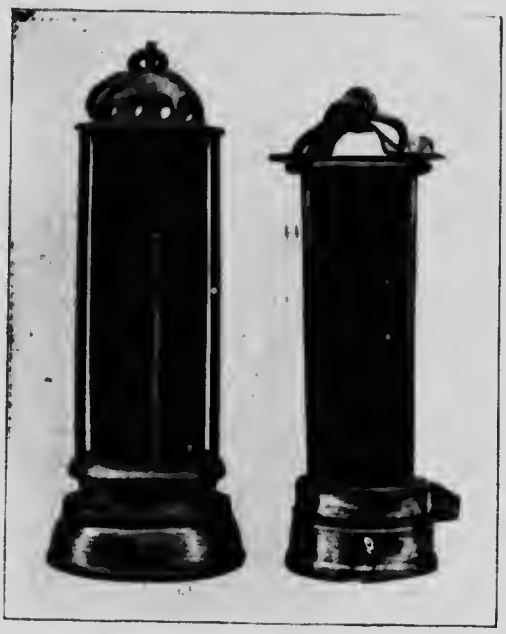


FIG. II.—(a) Davy Lamp. (b) Stephenson.

not be further referred to, as the Clanny type of lamp was the one in use at Fernie, and failures of this type will probably be of greater interest to Canadians.

At the Whitfield Colliery, North Staffordshire, in 1886, a Mueseler lamp (Fig. VI), which is a safer lamp than the Clanny, and is under ordinary circumstances automatically extinguished by an explosive current, failed entirely to resist what may be termed a very practical test. The lamp in question was hung on the side of a heading in the Cockshead mine (which is a thick coal having an inclination of about one in four), and the collier who was working by its light was moving

dirt out of an old level into which he had thurled. Whilst doing so a slight fall of roof took place in the old level, bringing down with it a small quantity of gas and dust, which, on coming in contact with the lamp, immediately exploded, and burned the man slightly. The lamp was carefully examined after the explosion, and was found to be quite correct, and to all appearances safe, but it was noticed that the lamp gauzes were perfectly clean, and as bright as a shilling, whilst another lamp hanging close against it was found to be very dirty from the dust.

To show that experimental results are often confirmed by practical

FIG. III.—Cambrian Davy Lamp for Firemen, showing glass part raised and the bonnet removed.

demonstration may be shown by the failure of a double gauze Marsaut lamp. The inventor of this type of lamp, in his book on safety lamps, states that he obtained one failure out of every nine tests with similar lamps when they were suddenly surrounded with an explosive mixture of firedamp and air. At the Wishaw colliery, Scotland, in 1895, an unbonneted Mueseler which was being used to test by a fireman for fire-

damp in a narrow heading partly ventilated by the exhaust from an engine worked by compressed air, suddenly passed the flame through both gauzes without the lapse of any appreciable interval, and immediately exploded the accumulated firedamp. Several miners who were present and saw what occurred were waiting to go into the heading to fetch out their tools, but no one was killed.

Passing on to the modern type of Clanny, viz., the one known as the bonneted Clanny, we find that at the Allerton Main colliery in

FIG. IV.—Clanny Lamps.

Yorkshire in 1894, whilst several men were engaged in placing, and also replacing some air pipes which were used to ventilate a heading through a fault, an explosion was originated by the failure of a bonneted Clanny lamp to withstand a mixture of air, firedamp, and dust, moving at a low velocity. These lamps were afterwards submitted to Prof. Lupton, of Leeds, who tested them in high velocities

of mixtures of firedamp and air, but without coal-dust, and failed to make them explode the outer atmosphere.

Another notable failure of a bonneted Clanny occurred at the Shakerley Colliery, Lancashire, in 1895, where a party of officials were engaged in trying to move an accumulation of gas by clearing an air-way. All the lamps had been extinguished excepting one, and the man who was using it was practically in a quiescent atmosphere, but the heading being old and very dusty, undoubtedly dust, disturbed by the movements of the men, was a factor, along with the mixture of firedamp and air, in causing this one lamp to fail and explode the mixture. Every man present was instantly killed. The lamp which had failed was tested by Mr. Hilton, of Wigan, who had had considerable

FIG. V.—Bonneted Clanny, Mueseler or Marsaut. Arrangement for gas-testing.

experience in the testing of safety lamps, but he could not explode it in any of the mixtures of fire-damp and air that he used. We may particularly note that in these experiments, as in those on the Allerton Main lamps, no coal-dust was added to the explosive mixture.

In the year 1901 we have the suggested failure of either a bonneted Davy or of a bonneted Clanny at the Universal Colliery, South

FIG. VI.—Mueseler Lamp.

Wales, in a mine which was both fiery and dusty, and in which men were engaged in one part of the mine, as at Allerton Main, in adding air pipes to ventilate a heading through a fault. Later in the same year, viz., on December the sixth, a non-fatal explosion of gas occurred at the Shirebrook Colliery in Nottinghamshire, which was worked exclusively with locked (magnetic locks) double gauze bonneted lamps of the Wolf type (Fig. VII). And the following is the Inspector of Mines' report on the occurrence :—

"A night shift of workmen was sent to do some road repairs near the coal face, and near a fault. The place to be repaired was a break-down of the roadway, leaving a high cavity in the roof. An official of the mine visited the place at about 11.15 p.m., and reported that he found no gas, and the men continued at work until "snap" time. They had just resumed work when the gas was ignited.

"The injured person had taken his lamp and placed it upon a bar about 8 feet 6 inches from the ground, whilst he stood upon a tub to

FIG. VII.—Wolf Lamp. Illuminant Benzolene. Showing arrangement for lighting without opening the lamp. Magnetic locking.

fix some timber across the cavity above the bar. While doing this work an explosion of gas occurred and burned the man who was standing upon the tub. The other man was uninjured, but a number of men ran to the shaft in a panic. The explosion set fire to two brattice sheets and a wood pack, and so quickly did the fire extend that but

for the energy of the officials and the use of hand grenades the fire would probably have soon been out of control, and have become exceedingly dangerous.

"After the extinction of the fire the firedamp again appeared, indicating that the fall of roof had liberated a small feeder from the fault. The lamp which was supposed to have fired the gas was carefully examined, but no serious defect was found."

This lamp was afterwards tested in an explosive mixture of gas and air without any failure. There was no appearance of overheating, and the gauzes were clean and free from dust.

These instances might be greatly enlarged if problematical cases

FIG. VIII.—Ashworth's patent Gray, Deputy or Fireman's Lamp. Showing mode of manipulation when testing for firedamp.

were added, but no event, as originating a colliery explosion, is so difficult to prove as the failure of a safety lamp, because the principal indication is not necessarily the evidence of an overheated gauze, but rather its great cleanliness as compared with other lamps in the immediate vicinity. This fact would, in the opinion of most people, be the most convincing proof that it had not failed. Experiments, as well as practical experience, has proved that the most dangerous condition to which a safety lamp may be subjected, is when the lamp is suddenly raised into an explosive atmosphere of firedamp, air, and dust, or when a ventilating current becomes suddenly charged with an access of firedamp, or approaching the lamp from the top

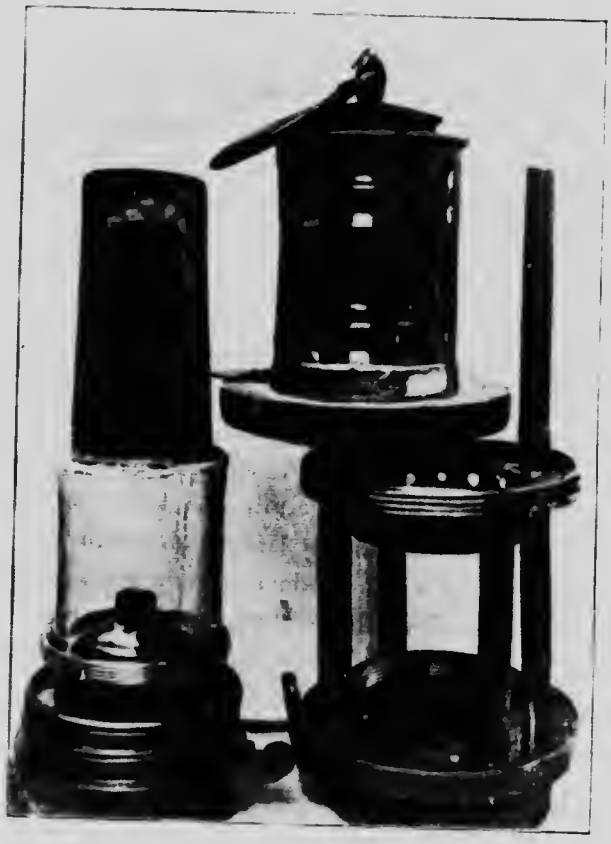


FIG. IX.—Gray's No. 2 Patent Safety Lamp for Deputies, Firemen or Miners. Showing gas-testing tube in position. Lead lock. Gives a particularly good light. Illuminant—paraffine or mineral colza.

crushes down the wick flame. From this proving, mine officials will readily understand that any lamp which admits of a down current, and the crushing down of the wick flame, cannot be a safe lamp to put into the hands of officials who have to examine the mine for gas, or who have to make careful tests of the place, and also the adjoining places to that in which a shot or shots may have to be fired.

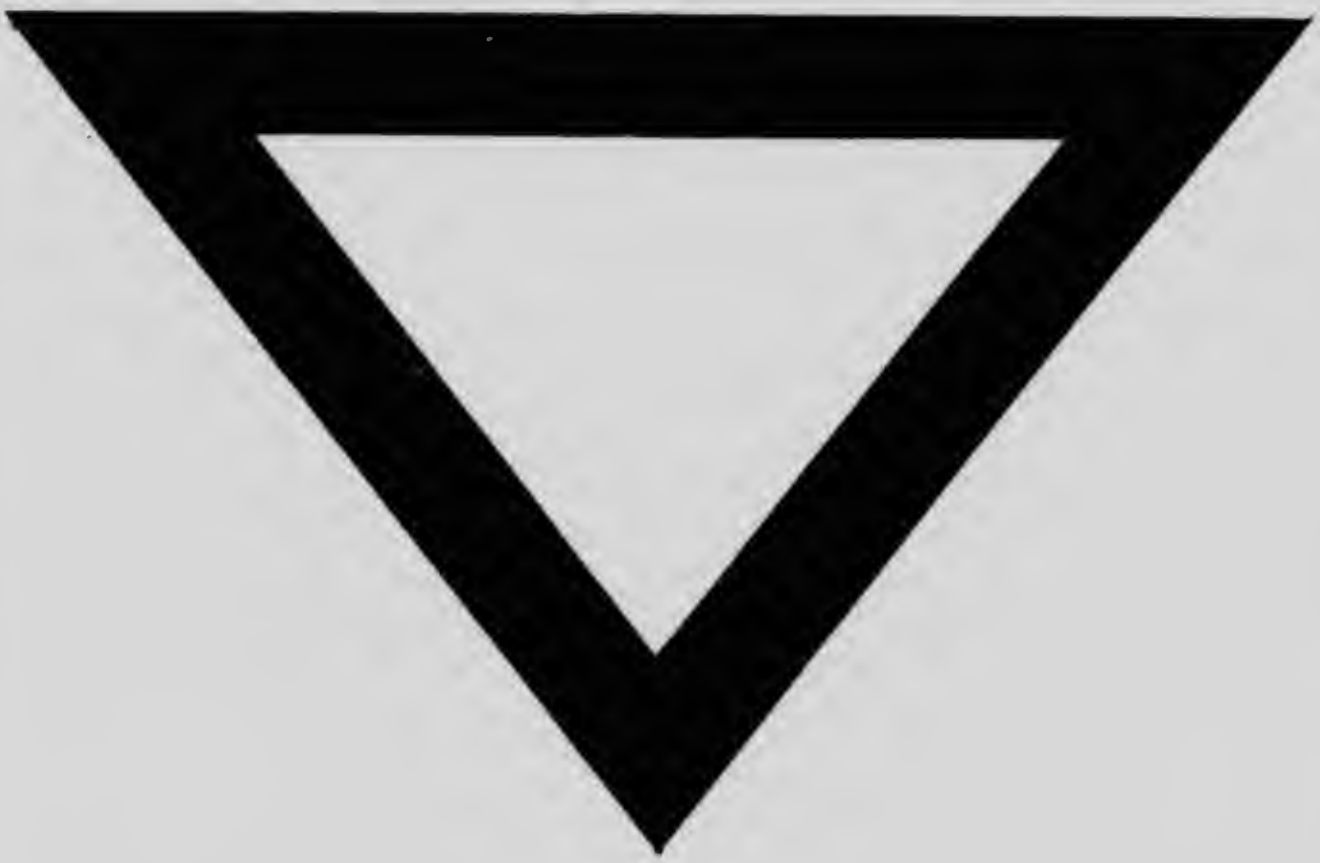
There are many sorts of lamps which are called deputies', firemen's, and shot firers' lamps, but very few of them are really safe to use under the conditions which surround the work of these officials. Yet there is one type of lamp which came out of the Royal Commission on Mine Accidents tests with distinguished honour, viz., the one known as the Gray. So impressed were the Commissioners by the suitability of this type of safety lamp for gas-testing, that one of the Commissioners, Prof. Clifton, tried to improve it. After the publication of the report an improved form was brought out by the writer, who has had a life-long experience in experimental work with safety lamps, and also in their practical use, and this lamp is well known throughout the English coal-fields and also in the colonies, as Ashworth's patent Hepplewhite Gray (Fig. VIII). The lamp, as thus improved, did not find the favor it might have been expected to have done in the fiery mines of South Wales, and so late as 1901 the original inventor, Mr. Gray, again took out a patent, which he calls No. 2, combining all the best points of the Gray and Ashworth lamps. Very long and careful practical experiments have been made with this lamp, and Mr Gray may be congratulated on being able to provide his officials with such a valuable, simple, and useful safety lamp with which to ascertain the real state of a mine, and which produces such a good illumination that it is a pleasure to pass along the roadways of a mine where everything can be clearly seen, and the old idea of groping about a pit with the miserable light of a Davy lamp is no longer necessary. This type of lamp may be so constructed that it will be automatically extinguished when in a miner's hands if the air current becomes in any way fouled by a percentage of firedamp which would be indicated only faintly on the flame of a Davy lamp. It is also impossible to produce a down current, that is, to reverse the air current within the lamp, so well are the inlet and outlet air openings protected, and the lamp may be carried

in any current of air without its being extinguished. Fig. IX shows the lamp in sections, and on reference to this it will be seen that when the lamp is not being used for the purpose of gas detection all the air required for combustion, and to keep the lamp cool, enters directly above the cylindrical glass, and, passing down the four air tubes which replace the ordinary solid standards connecting the top part of the lamp with the bottom, goes through the ring gauze below the glass, and after supplying the wick flame, finds its escape with the products of combustion through the conical tin chimney, and then, as an extra protection through the slightly conical gauze which entirely covers and surrounds the chimney, and finally into the surrounding air through the double deflector openings in the top of the shield, as well as through a hole in the extreme top of the shield, which is perfectly protected from all down or angular currents by the baffle plate to which the handle is attached. As no mining laws in any part of the world make any stipulations with regard to the percentage of firedamp which a safety lamp shall be capable of detecting, it is only necessary to say that this lamp will detect more readily, and with greater certainty, the presence of the "blue cap" than any Davy lamp which was ever made. When the fire boss, fireman, deputy, or other official wishes to make a test for firedamp, he puts his hand in his pocket, and, taking out a short brass tube, places it on to one of the fixed air tubes, and is thus enabled to test the condition of the mine close up to the roof, without canting the lamp. If firedamp is present, it passes down this single tube, and is indicated on one side of the wick flame without extinguishing it, and no form of bonneted Davy, Clanny, Mueseler, or Marsaut can make such a close test either so quickly or so accurately.

If such a lamp as this had been in use at the Fernie mines, it would have been impossible, excepting with the grossest and most criminal negligence, to have allowed a shot to be fired when the mine was in an unfit state for shot-firing. Not only is a mine jeopardized by inaccurate examinations for firedamp, but by the class of workmen employed, as stated in the CANADIAN MINING REVIEW in the issue of February 28th, 1901. That this risk is not confined to the Fernie mines was amply demonstrated by a recent explosion in a pit near Wigan, England, where the contractor for the work, finding that the

pit was dangerously fouled with firedamp, sent all the safety lamps out of the pit, and left his men to continue their work by the aid of electric lamps coupled direct to a cable from the pit top, but during the shift, a Pole, who could not read English, struck the main cable with his spade, causing a short circuit and an arc which originated an explosion of the accumulated firedamp, and which killed nearly every man in the pit, as well as the man on the top of the pit. Judging from the plan of Mine No. 2, printed in the CANADIAN MINING REVIEW, of the 31st of March, 1901, it would appear that an electric pump was at work in a place ventilated by return air, and in the immediate vicinity of a large area of gob, which, if unventilated, as shown, could not fail to be a source of very great danger, and would make the examinations of firedamp of even greater importance than in a mine where electricity was not in use.

A mine at such a high altitude above the sea must present points of great scientific interest. Thus, the barometrical pressure is very low compared with English fiery mines, showing a difference of at least six inches of mercury, and probably the air is very dry, therefore, if a low barometer indicates a danger, the dry state of the air compensates the danger to some extent. And moreover, as every cubic foot of air contains less oxygen than in an English deep mine, the proportions of air and firedamp required to form an explosive mixture must be altered also. It is therefore more than probable that the capacity of any lamp to detect firedamp will be lessened by a low barometer, and raised by a high barometer, because the heat of the testing flame will be reduced by the low barometer. Under like circumstances, the lighting power of safety lamps will be reduced, and if candles have to be abandoned an ordinary type of safety lamp like the Clanny will be a poor substitute.

The capacity of a safety lamp to detect small percentages of firedamp depends entirely on its heat and its non-luminosity, but principally on its heat, and these are the reasons why hydrogen gas and alcohol spirit were adapted by the writer to his Hepplewhite-Gray type for laboratory and main air current testing in coal mines.

In conclusion we should recommend Canadian colliery managers to carefully consider the subject of gas detection, and thus provide against the horrors of colliery explosions as well as against the great loss of capital which these disasters inevitably cause.